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(54) IMPROVEMENTS IN OR RELATING TO ELECTRIC DISCHARGE LAMPS

(71) We, THE GENERAL ELECTRIC COMPANY LIMITED (formerly The General Electric and English Electric Companies Limited), of 1, Stanhope Gate, London, W.1, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electric discharge lamps of the kind (hereinafter referred to as the kind specified) comprising a discharge envelope which contains a metal filling consisting of sodium and at least one additional metal, and, suitably disposed within said envelope, two electrodes between which an electric discharge is arranged to pass through the mixed metal vapour in operation of the lamp, the amount of the filling being such that a total vapour pressure of at least 400 millimetres of mercury is attained in normal operation of the lamp. The invention is an improvement in or modification of the invention claimed in Claim 1 of co-pending Patent Application No. 3001/68 (Serial No. 1,192,094).

The metal or metals included in the lamp filling in addition to sodium is or are incorporated in the filling for modifying the colour of the light emitted by the lamp in operation. The light emitted by a discharge in sodium vapour alone has a colour temperature of about 2000°K and is of a markedly yellow colour, and the additional metal or metals is or are so chosen that the colour temperature of the light emitted by the discharge in the mixed metal vapours will be increased, to give light having an appearance more closely similar to that of natural daylight, and having better colour rendering characteristics, than is the case with the sodium emission alone. Furthermore the additional metal employed is preferably one which has a higher vapour pressure than that of sodium, the amount of the additional metal used being sufficient to ensure that, in operation of the lamp, the partial pressure of sodium vapour is restricted whilst the total pressure of the filling is increased above that corresponding to the equivalent vapour pressure of pure sodium. The effect of this is to constrict the discharge and increase its temperature, and so modify the output from the excited sodium atoms that a better colour balance of the sodium spectrum is obtained. The spectrum of the additional metal may or may not contribute to the light output, depending on the ratio of the amount of sodium to the amount of additional metal present and the relative excitation levels of the metal components of the filling.

A particular metal which has been proposed for use in conjunction with sodium to form the metal filling of lamps of the kind specified is mercury: the filling of a sodium-mercury lamp suitably consists of about 20% sodium and 80% mercury, by weight, together with a small amount of rare gas, the amount of the metal filling preferably being sufficient to develop substantially atmospheric pressure, with a partial pressure of sodium vapour of 150 to 200 mm of mercury, in operation of the lamp at normal operating temperatures. Mercury has a vapour pressure considerably in excess of that of sodium, and the presence of mercury in the filling effectively increases the colour temperature of the light to about 2100°K when the relative proportions of sodium and mercury are suitably chosen as indicated above. Whilst the light emitted by discharge lamps having a sodium-mercury filling is thus considerably closer to daylight, in appearance and colour rendering properties, than that emitted by sodium discharge lamps containing no other metal, a still greater improvement in both respects is desirable.

In Claim 1 of co-pending Application No.

[*Price 25p*]

3001/68 (Serial No. 1,192,094) there is claimed an electric discharge lamp of the kind specified wherein the metal filling consists of sodium and cadmium and optionally thallium, the proportion of sodium being in the range of 1% to 15% by weight of the total metal filling and, if thallium is included, the weight ratio of thallium to cadmium being in the range of 1:1 to 9:1. Such a filling is capable of producing light more closely resembling daylight, in respect of appearance and colour rendering properties, than the light emitted by a discharge lamp having a metal filling consisting of sodium and mercury.

We have now found that the filling of a lamp in accordance with the aforesaid copending Application can be modified by complete or partial replacement of the cadmium by zinc or lead, or by a mixture of zinc and lead, the thus modified fillings giving similar improvements, in the appearance and colour rendering properties of the light emitted by the lamp, to those obtained with the sodium-cadmium and sodium-cadmium-thallium fillings in accordance with the aforesaid Application.

Thus according to the present invention, in an electric discharge lamp of the kind specified, which is an improvement in or modification of the lamp claimed in Claim 1 of co-pending Application No. 3001/68 (Serial No. 1,192,094), the metal filling consists of sodium together with zinc and/or lead, optionally cadmium, and optionally thallium, the proportion of sodium being in the range of 1% to 15% by weight of the total metal filling.

The component of the metal filling other than sodium and possibly thallium may consist of zinc only, or lead only, or lead and zinc in any relative proportions, or zinc and/or lead and cadmium in any relative proportions; thus the cadmium is replaceable by zinc and/or lead to any desired extent, since the effects of both zinc and lead on the sodium discharge emission are similar to the effects produced by cadmium, as described in the specification of the aforesaid copending Application. Thus the emission spectra of zinc and lead are such that when either of these metals is used in conjunction with sodium the effect on the colour temperature of the light produced, and hence on the appearance and colour rendering characteristics of the light, is similar to the effect of cadmium, the light being more closely similar to daylight than is the case with the light emitted by a sodium-mercury lamp. Furthermore, as is the case with cadmium, the inclusion of zinc and/or lead in the filling results in an increase in the efficiency of the lamp as compared with that of a lamp having a metal filling consisting of sodium only, the efficiency again increasing linearly with increasing wattage. The inclusion of thallium, in addition to zinc and/or lead, with or without cadmium, results in further improvement in both the colour of the emitted light and the efficiency of the lamp.

In order to ensure that suppression of the vapour pressure of the sodium at any required temperature is achieved, the proportion of sodium present is only from 1% to 15% by weight of the metal filling, as indicated above. Where the metal filling includes two or more of the metals zinc, lead, cadmium and thallium, the relative proportions of these metals present can be varied as desired to enhance any particular line or lines in the spectrum of the emitted light. Some examples of preferred ranges of metal filling compositions, in weight percentages, are as follows:—

(1) 85% to 99% zinc, and 15% to 1% sodium.
(2) 50% zinc, 35% to 49% thallium, and 15% to 1% sodium.
(3) 50% thallium, 30% cadmium, 5% to 19% zinc, and 15% to 1% sodium.

The filling of a discharge lamp in accordance with the invention includes, in addition to the metals specified, a small amount of one or more rare gases, for example xenon or a mixture of argon and neon, for facilitating starting of the discharge in operation, as is usual in lamps of the kind specified.

A metal filling in accordance with the invention is especially suitable for use in lamps of the kind specified designed to have high power loading in operation, for example a loading of 75 to 100 watts per centimetre of arc length.

A lamp in accordance with the invention is suitably of the form described in the specification of Application No. 3001/68 (Serial No. 1,192,094), that is to say having a tubular discharge envelope formed of light-transmissive sintered polycrystalline alumina containing up to 1% by weight of magnesium oxide, and closed at each end by a suitable metal closure member sealed to the alumina tube by means of an active alloy sealing layer, each closure member carrying a tungsten electrode disposed coaxially within the envelope.

The closure members, which are preferably of niobium, sealed to the alumina tube by means of an alloy of titanium, vanadium and zirconium as described in Patent Specification No. 1,065,023, may be in the form of discs, caps, plugs, or hollow cylinders inserted within the alumina tube and sealed thereto by means of flanges provided at the outer ends of the cylinders. The last-mentioned form of closure member, which is described in Patent Specification

No. 1,107,764, is particularly suitable for use in lamps designed to have a high loading in operation.

One specific form of electric discharge lamp in accordance with the invention will now be described in the following example.

The lamp of the example is of the form shown in the drawing accompanying the Provisional Specification of Application No. 3001/68 (Serial No. 1,192,094), comprising a tubular discharge envelope of sintered polycrystalline alumina containing 1% by weight of magnesium oxide, 86 mm long and 8 mm in internal diameter, closed at each end by a flanged hollow cylindrical closure member of niobium, the flanges of which closure members are sealed to the ends of the alumina tube by means of a titanium-vanadium-zirconium alloy. Each closure member carries a tungsten electrode disposed coaxially within the alumina tube, and a niobium exhaust stem is attached to one of the closure members. The lengths of the cylindrical closure members and the electrodes are such that the arc length between the inner ends of the electrodes is 50 mm.

The lamp is mounted coaxially within a cylindrical glass outer jacket designed to maintain the discharge envelope at a suitably high temperature when the lamp is in use, electric current supply leads being connected to the electrodes. If desired, radiation shields of refractory metal, for example tantalum, may be mounted within the outer jacket, so as to surround the discharge envelope in the regions of the electrodes, for enhancing the vapour pressure in the lamp and thus enabling the lamp to be operated at lower loadings if desired, or alternatively the outer jacket may be provided with an interior surface coating of an infra red-reflecting film.

In one specific example of a lamp of the form described above, the discharge envelope contains a metal filling consisting of 90% zinc, 8% thallium and 2% sodium, by weight, together with xenon at a pressure of 20 mm of mercury at room temperature. In normal operation of the lamp, the power dissipation is 400 watts, giving a power loading of 80 watts per centimetre of arc length, the voltage and current across the lamp are respectively 100 volts and 4.5 amperes, and the total vapour pressure attained by the filling is 400 mm of mercury, including a sodium vapour pressure of 200 mm. Under these conditions, the lamp emits light of a colour temperature of 2300°K, and operates at an efficiency of 90 lumens per watt

WHAT WE CLAIM IS:—

1. An electric discharge lamp of the kind specified, which is an improvement in or modification of the lamp claimed in Claim 1 of co-pending Patent Application No. 3001/68 (Serial No. 1,192,094), wherein the metal filling consists of sodium together with zinc and/or lead, optionally cadmium, and optionally thallium, the proportion of sodium being in the range of 1% to 15% by weight of the total metal filling.

2. A lamp according to Claim 1, wherein the metal filling consists of 85% to 99% zinc and 15% to 1% sodium, by weight.

3. A lamp according to Claim 1, wherein the metal filling consists of 50% zinc, 35% to 49% thallium, and 15% to 1% sodium, by weight.

4. A lamp according to Claim 1, wherein the metal filling consists of 50% thallium, 30% cadmium, 5% to 19% zinc, and 15% to 1% sodium, by weight.

5. A lamp according to any preceding claim, which is designed to have a power loading of 75 to 100 watts per centimetre of arc length in operation.

6. A lamp according to any preceding claim, which comprises a tubular discharge envelope formed of light-transmissive sintered polycrystalline alumina containing up to 1% by weight of magnesium oxide, which envelope is closed at each end by a niobium closure member sealed to the alumina tube by means of an alloy of titanium, vanadium and zirconium.

7. An electric discharge lamp according to Claim 1, substantially as described in the foregoing specific example.

For the Applicants,
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